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# THE ROAD DRAG AND HOW IT IS USED.

Prepared by the Office of Public Roads.

## INTRODUCTION.

An attempt will be made in this paper to describe the best methods of constructing and using road drags and to supply information concerning the conditions for which such drags are adapted. Since, under favorable conditions, road drags may be effectively used in maintaining roads constructed of earth, top soil, sand clay, or gravel, a brief discussion of the essential features of each of these types of construction will also be given in order that the purposes of the drag may be more fully understood.

When it is appreciated that of more than 2,000,000 miles of public roads in the United States only about 200,000 miles have been given a hard surface, and of these 200,000 miles approximately one-half are surfaced with gravel, the importance of every effective device for maintaining the simpler types of roads becomes readily apparent. It should be observed in this connection that a large part of our total mileage of public roads is entirely unimproved and that the drag is of little use in improving sand or clay roads which have never been crowned or drained. A much larger part, however, has been sufficiently improved to make the work of the drag effective, and it is unquestionably true that the magnitude of this part is steadily increasing.

Notwithstanding the fact that road drags, made of wood or a combination of wood and metal, have been in use for at least two generations and were described in a textbook published as early as 1851 (Roads and Railroads, by William Gillespie, p. 191), the benefits to be derived from using them are, even now, far from being generally understood. This fact is thoroughly evidenced by the prevalence of very unsatisfactory roads upon which considerably more money is annually expended in hauling materials to fill holes and ruts than would be required to maintain the roads in good condition by the intelligent use of a road drag.

NOTE.—This bulletin contains instructions for constructing road drags and directions for their use in the repair and maintenance of earth, top-soil, sand-clay, and gravel roads.

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## PURPOSE OF THE DRAG.

The drag is a simple and inexpensive device for maintaining certain types of roads which when wet become rutted under traffic and which become firm on drying out. It is also well adapted for producing a smooth and uniform surface on newly constructed roads in which the material used for surfacing is earth, earthy gravel, or some similar material. When the construction of the drag is discussed later, however, it will be obvious that it is essentially a maintenance implement and that its use in construction is distinctly secondary. It will also be apparent that roads which are very rocky or very sandy can not be materially improved by its use.

Properly used at the right time the road drag performs four distinct offices. First, by moving at an angle to the traveled way it tends to produce or preserve a crowned cross section. Second, if used when the material of the surface is not compact and hard, it tends to reduce ruts and other irregularities in the road by moving material from points which are relatively high to those which are relatively low. Third, when used after a rain it accelerates the drying out of the road by spreading out puddles of water and thus increasing the surfaces exposed to evaporation. Fourth, if the surface material is in a slightly plastic state, dragging smears over and partially seals the so-called pores which naturally occur in earthy material, and thus makes the road surface more or less impervious to water. The advantage of this smearing action of the drag will be more readily understood if a sample of ordinary earth is examined under a magnifying glass. Such an examination will show that the earth closely resembles a sponge or honeycomb in structure, and the desirability of closing the open pores will be readily apparent.

If used improperly or at the wrong time, the drag may do actual injury to a road. Dragging a very dry road, for example, serves to increase the quantity of dust and may do additional damage by destroying the seal produced during previous dragging. If, on the other hand, the road is very wet and muddy, the irregularities in the surface are likely to be increased rather than diminished by dragging.

## HOW THE DRAG IS CONSTRUCTED.

The accompanying illustrations (figs. 1 and 2) show two typical designs for road drags, either of which is very simple and inexpensive. The design shown in figure 1 contemplates the use of an ordinary log of timber, such as may be readily obtained in almost every locality. The log should be about 7 or 8 inches in diameter and from 6 to 8 feet long, and should preferably be of hard, tough wood which will not decay very rapidly when exposed to the weather. White oak, burr oak, chestnut, cedar, hickory, walnut, or any similar wood may be

satisfactorily used, provided that it is well seasoned before the drag is put into use. Railroad ties have been frequently used for this purpose and possess the advantage that they are already cut to about

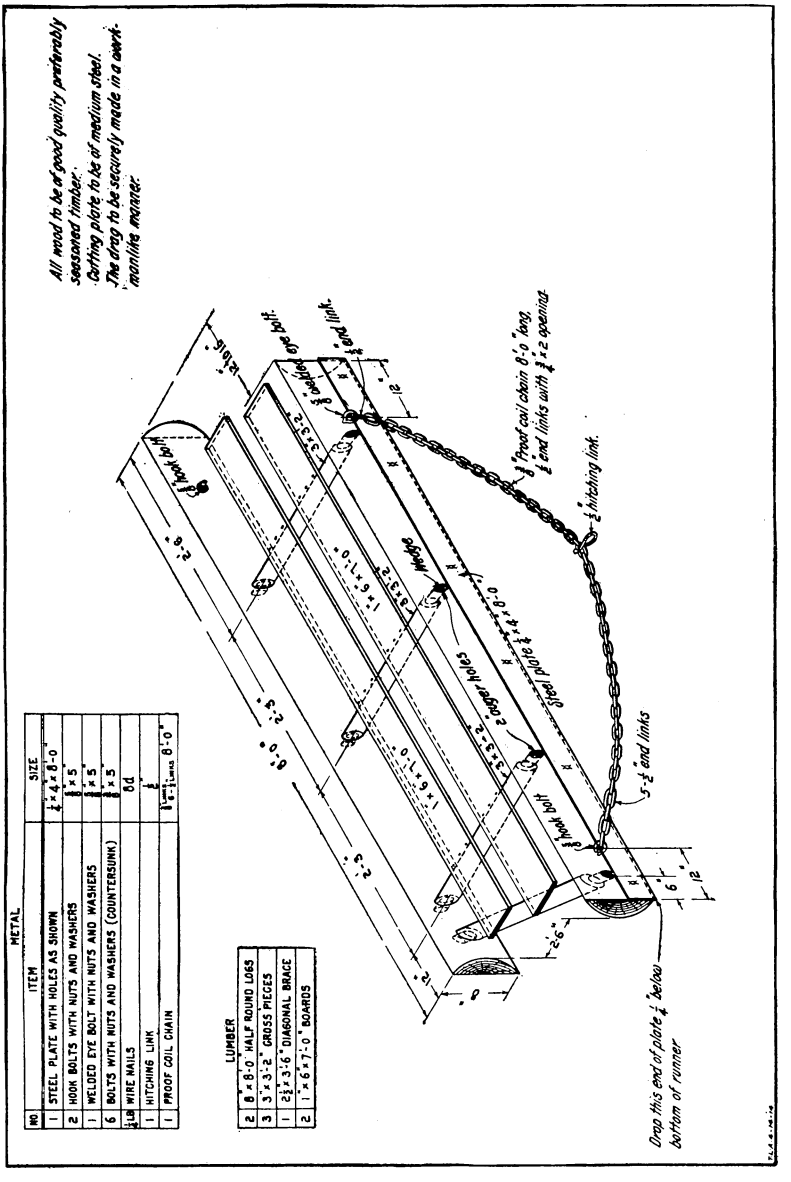


FIG. 1.—Detail drawing showing typical construction of split-log road drag.

the right length. In selecting the tie, however, care should be exercised to see that it is of sound wood and of the proper size.

The drag is made by splitting or sawing the log into two equal semicylinders, which are then framed together in the manner shown

in figure 1. The better of the two pieces should form the front runner of the drag, because it is the one subjected to the greater wear. Moreover, while the front runner should always be placed with the face forward, it is claimed by many that better results may be obtained by having the round part of the back runner go forward in order to increase the smearing action of the drag. The two runners are usually spaced from about 30 inches to 36 inches apart, and are connected in ladder fashion by means of cross stakes or rungs.

The ends of the rungs are ordinarily fitted into 2-inch auger holes, bored in the runners, and are securely held in place by means of end wedges. The auger holes are so arranged that the runners, when framed together, will be displaced in a longitudinal direction with respect to each other. The object of this displacement, or offset as it is usually termed, is to make the ends of the front and back runners follow approximately the same line on the road while the drag is in operation. The amount of displacement, therefore, should depend on the amount of skew necessary to make the drag empty itself. But since this skew varies with the condition of the road surface, the proper offset to be given to runners can not be definitely fixed. Under ordinary conditions an offset of from about 12 inches to about 16 inches will prove satisfactory.

In order to make it easy for a man to stand upon the drag and to shift his weight properly when dragging over a hard surface, the drag should be provided with two 1-inch boards parallel to the runners and nailed down to the rungs. These boards should be about 8 inches wide and their length should be slightly less than that of the runners of the drag.

The chain by means of which the drag is drawn should be about 8 feet long and its links should be made of three-eighths-inch steel. On light drags two trace chains may be used for this purpose. The hitching link, which is designed so that its position on the chain may be readily changed, should be made of one-half-inch steel. If desired, an ordinary clevis may be substituted for the hitching link shown in the designs. It is also well to use a few half-inch links at each end of the chain, because the wear is greater at these points. It is customary to fasten the chain to the drag by running one end through a hole near the discharge end of the front runner and by looping the other end over the rung at the cutting end of the front runner. This is a very simple way of connecting the chain, but it has the disadvantage that it tends to rack the drag to pieces, and the method of connection shown in figure 1 is therefore to be preferred.

Many road drags constructed as above described, without metal cutting edges or other modifications, have been very satisfactorily used where the conditions were favorable. It is evident, however, that such drags are effective only on comparatively soft road surfaces,

and to diminish this limitation and also to increase the life of the drag it is very desirable to provide a metal cutting edge for the front runner. An excellent edge of this kind may be made from a strip of iron or steel about one-fourth inch thick and about 4 inches wide, and even old wagon tires or worn-out grader blades have been very satisfactory.

The cutting edge may extend along the entire length of the front runner, or it may extend along only a part of this length and leave the discharge end of the runner without protection. The advantage of the first method is that the entire front runner is protected from fraying and wearing. The second method affords a slight operating advantage in that the discharge end of the runner is somewhat better adapted to spreading out and compacting the material which it releases while in operation. A skillful operator, however, can usually so adjust the hitching link or shift his weight, if he is riding upon the drag, that the discharge end of the front runner will satisfactorily spread the material which is moved, even when the metal-cutting edge extends throughout its length.

The design for a road drag shown in figure 2 is adapted for localities in which sawed lumber may be readily obtained. In this design the runners are made of 2 or 2½ inch boards, 10 inches wide and from 6 to 8 feet long, reinforced with other 2-inch boards of the same length, but only 6 inches in width. If more convenient, however, 4-inch runners without reinforcing boards may be readily substituted for those shown. The method of framing the runners together is a modification of that described in connection with the split-log type of drag. In this case only two of the cross braces have their ends fitted into augur holes like rungs, while all other bracing is "dapped" nto the runners and secured by means of nails.

In fastening the draw-chain to a sawed lumber drag, it is usually advisable to run both ends of the chain through holes in the front runner or else make the connections by means of eye or hook bolts, as shown in figure 2. The reason for this is that the sawed cross braces are seldom sufficiently strong to withstand the pull of the chain when it is looped over them, as is frequently done when round timber crosspieces are used. If straight-grained pieces are used for the crosspieces, however, there is no apparent reason why one end of the chain might not be connected by looping it around the 2½-inch square crosspiece near the cutting end.

In addition to the two common types of road drags which have already been described, there are a number of special types which may be advantageously used under certain circumstances. For example, a drag such as is used by many farmers for smoothing over newly plowed fields may be constructed by nailing together 1-inch boards, siding fashion, in such manner that the ends of the boards

will line up approximately with the road when the drag is properly skewed for operating. The drag should be made of boards about 5 or 6 feet long and should be provided with about four 2 by 4 inch cleats on the top side. These cleats not only serve as nailing strips

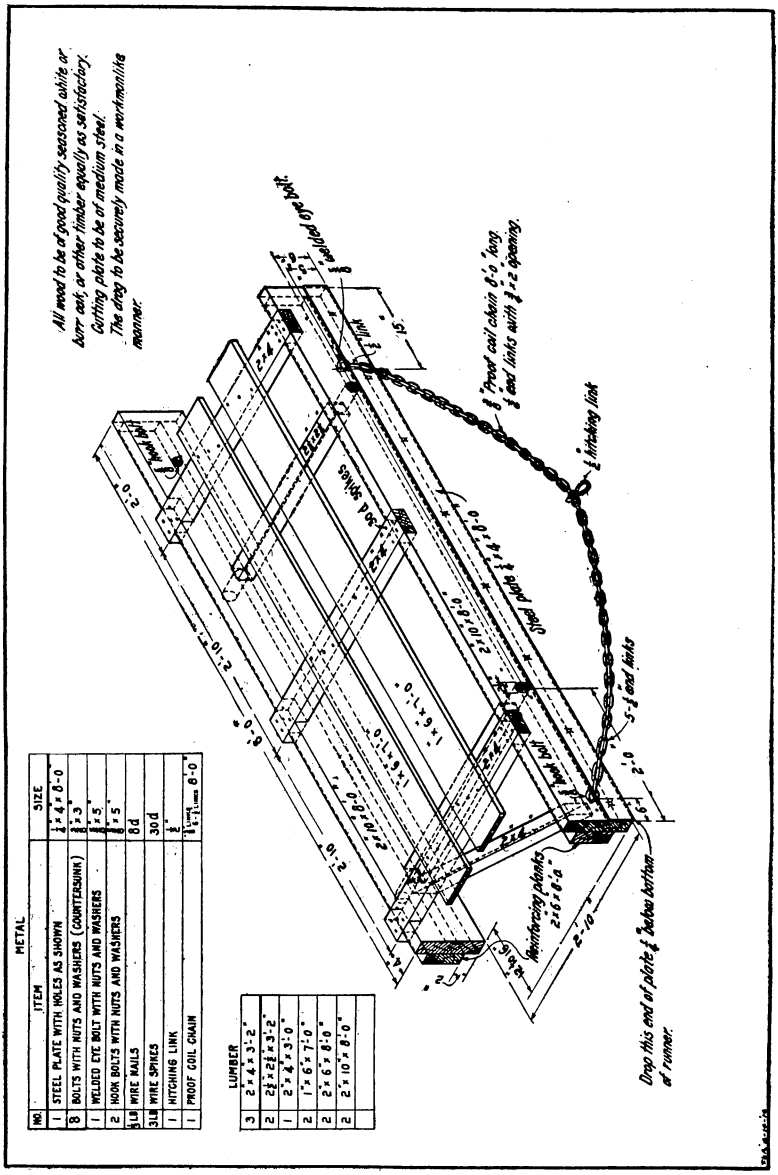


FIG. 2.—Detail drawing showing typical construction of road drag built of sawed lumber.

for the boards, but furnish a very convenient means for fastening the draw chain to the drag.

A drag constructed of boards as just described may be readily drawn by one horse, and is sometimes very useful in securing a

smooth surface on newly constructed earth or sand-clay roads. One of the two general types, already described, however, is in general to be preferred.

Several different types of steel road drags are now on the market, and some of these have been used with very satisfactory results. One very distinct advantage which steel drags possess is that they may be so constructed that the runners or blades can be readily shifted longitudinally with respect to each other, and thus adjusted to suit any angle of skew at which it is deemed desirable to run the drag. The principal disadvantage is that the smearing action of the wooden drag is largely lost. Steel drags are also much more expensive than those made of wood or a combination of wood and metal, such as are shown in the designs which have already been described.

## HOW TO USE THE DRAG.

The principal factor in successfully operating a properly constructed road drag, provided that the condition of the road is favorable, is skill on the part of the operator. Such skill can be obtained only by intelligent experience in the use of the drag, and no rules can be laid down which would enable an inexperienced operator to produce first-class results. The following suggestions are intended, therefore, to serve rather as a guide to the judgment than as a criterion to be implicity followed.

Under ordinary circumstances the position of the hitching link on the draw chain should be such that the runners will make an angle of from 60° to 75° with the center line of the road, or in other words, a skew angle of from 15° to 30°. It is apparent that by shifting the position of the hitching link the angle of skew may be increased or diminished as the conditions require. When dragging immediately over ruts or down the center of the road after the sides have been dragged, it is usually preferable to have the hitching link at the center of the chain and to run the drag without skew. When the principal purpose of the dragging is to increase the crown of the road, the drag should be sufficiently skewed to discharge all material as rapidly as it is collected on the runners. On the other hand, if depressions occur in the road surface, the skew may perhaps be advantageously reduced to a minimum, thus enabling the operator to deposit the material which collects in front of the runners at such points as he desires by lifting or otherwise manipulating the drag. Many other examples of conditions which require modifications in the angle of skew might easily be cited, but these will readily suggest themselves to an intelligent operator as his experience increases.

The length of hitch is another very important consideration in operating a road drag. In the designs which have been discussed the draw chain may be readily taken up or let out at either end and the length of hitch thus increased or diminished as desired. It is imprac-

ticable to prescribe even an approximate rule for fixing the length of hitch, because it is materially affected by the height of the team and the arrangement of the harness, as well as by the condition of the road surface. Experience will soon teach the operator, however, when to shorten the hitch in order to lessen the amount of cutting done by the front runner and when to lengthen it in order to produce the opposite effect.

When the road surface is sufficiently hard or the amount of material which it is desired to have the drag move is sufficient to warrant the operator standing upon the drag while it is in operation, he can greatly facilitate its work by shifting his weight at proper times. For example, if it is desired to have the drag discharge more rapidly, the operator should move toward the discharge end of the runners. This will cause the ditch end of the runners to swing forward and thus increase the skew angle of the drag. The operator may, of course, produce the opposite effect by moving his weight in the opposite direction. In the same way, he can partially control the amount of cutting which the drag does by shifting his weight backward or forward, as the case may be.

An intelligent and interested operator will soon learn many simple ways by means of which he can easily control the different features of the work which a drag performs, and he will also learn to utilize effectively every effort which his team exerts. Unskilled or indifferent operators, on the other hand, may do actual injury to a road by dragging it in an improper way, and they generally waste a large part of the work which their teams perform. Cases are not infrequently observed in which no care whatever is exercised to see that the team is properly hitched to the drag or to determine when the operator should ride and when walk. Very often the operator seems to think that the drag is, or at least ought to be, an automatic device, and that his function is merely to drive and ride. It is almost needless to say that under such conditions as these, the road drag usually proves a failure.

## WHEN TO USE THE DRAG.

It is fully as important that a road be dragged at the right time as it is that the dragging be properly done. Furthermore, the difficulties involved in prescribing definite rules for determining when dragging should be done are equally as great as those already encountered in attempting to define how it should be done. Only very general statements concerning this feature of the work can properly be made here, and much must be left to the experienced judgment of those who decide when the dragging of any particular road is to be started and when it is to be stopped.

The rule frequently cited, that all earth roads should be dragged immediately after every rain, is in many cases entirely impracticable

and is also very misleading because of the conditions which it fails to contemplate. It is true that there are many road surfaces composed of earth or earthy material which do not become very muddy

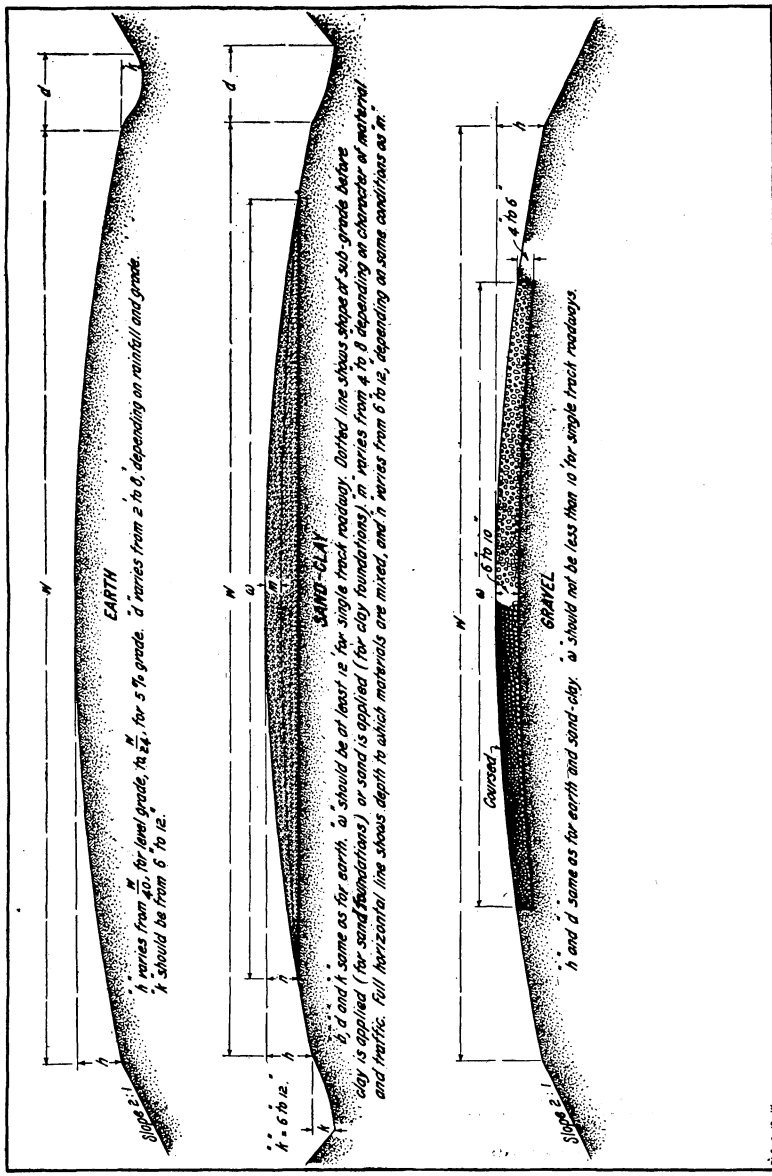


FIG. 3.—Cross section showing typical construction of earth, sand-clay, and gravel roads.

under traffic, even during long rainy seasons, and since such surfaces usually tend to harden very rapidly as soon as the weather clears up, it may be desirable to drag roads of this kind immediately after a rain. Such roads, however, would not ordinarily need to be dragged

after every rain, because of the strong tendency that they naturally possess of holding their shape. On the other hand, many varieties of clay and soil tend to become very muddy under only light traffic after very moderate rains, and it is evident that roads constructed of such materials could not always be successfully dragged immediately after a rain. Sometimes, in fact, it may be necessary to wait until several consecutive clear days have elapsed after a long rainy spell before the road is sufficiently dried out to keep ruts from forming almost as rapidly as they can be filled by dragging. In many cases of this kind, however, it is possible greatly to improve the power of the road to resist the destructive action of traffic during rainy seasons by repeatedly dragging it at the proper time.

Well-constructed sand-clay and topsoil roads should not often become muddy after they are once well compacted. They may become seriously rutted, however, under heavy traffic, during rainy weather, and are almost sure to need dragging several times each year. Such roads should ordinarily be dragged as soon after a rain as practicable, as otherwise the surface soon becomes dry and hard, so that it is necessary to do considerably more dragging in order to fill the ruts. Furthermore, the material which the drag moves will not compact readily unless it contains a considerable amount of moisture.

Gravel roads can be effectively maintained with a road drag only when the gravel composing the surface is fine grained and contains a considerable quantity of clay or earth. Gravel road surfaces in which this condition prevails not infrequently get badly out of shape during wet weather, and may sometimes require considerably more attention than well-constructed sand-clay or topsoil roads. The time for dragging gravel roads is unquestionably while they are wet. In fact, the best results are sometimes obtained by doing the dragging after the road has become thoroughly soaked and while it is still raining.

In general, it may be said that the best time to drag any type of road is when the material composing the surface contains sufficient moisture to compact readily after it has been moved by the drag and is not sufficiently wet for the traffic following the drag to produce mud.

## FEATURES OF ROAD CONSTRUCTION INVOLVED.

In order that the maintenance work of the drag may be effective, it is essential that the roads which are to be maintained first be constructed. The drag is, of course, useful in smoothing the surface of roads which are entirely unimproved, but it should not be expected to keep the surface of a road smooth and uniform until the road has first been properly graded, drained, and crowned.

Figure 3 shows typical cross sections for roads constructed of earth, of sand-clay, and of gravel. The sand-clay section may also be used for topsoil roads, except that, as a rule, no material from the roadbed is mixed into the surface when topsoil is used. These sections are all well adapted to drag maintenance, provided that they are employed in conjunction with the other essential features of road construction. It should be remembered, however, that no typical section could be shown which would be applicable to all cases. The character of the material of which the road is constructed, for example, has a very important bearing on the crown of the surface. Moreover,

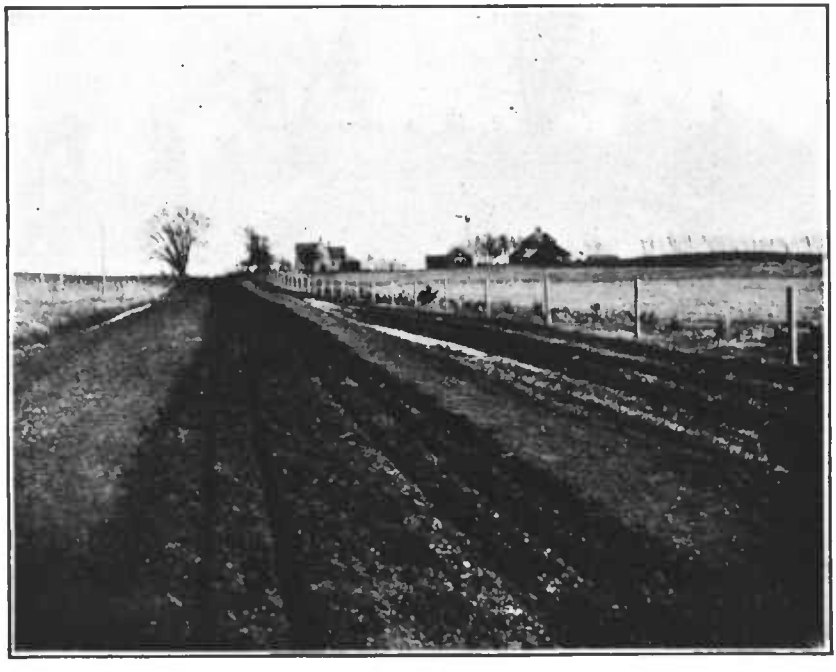

FIG. 4.—Earth road in Jackson Township, Hardin County, Iowa, before dragging.

climatic or soil conditions may make it desirable to change entirely the section of the side ditches.

The only reason for crowning a road surface is to enable it to shed water, and unless effective means are provided for disposing of the water after it is drained off the surface crowning will be of very little, if any, advantage. The side ditches should be amply large and should have sufficient fall to carry the water away as rapidly as it enters them, and they should have outlets at all convenient points. Cross drains or culverts should be constructed wherever it is desirable to transfer drainage water across the road, and they should usually be provided with end or wing walls for protecting the slopes of the embankment. When the material composing the roadbed is

likely to be springy, a system of longitudinal underdrainage may be found necessary to secure proper drainage. In constructing a road, of any type whatever, it should be constantly borne in mind that adequate and continually effective drainage is absolutely necessary if the road is to be maintained in good condition.

Road surfaces of sand-clay and topsoil and gravel road surfaces of the kind susceptible to drag maintenance are really nothing more than modifications of the ordinary natural earth road surface. These surfaces are usually employed only when the natural material of the roadbed is of an inferior quality of earth, such as sand, sticky clay,

FIG. 5.—The earth road shown in figure 4 after dragging.

gumbo, loam, or other material which does not tend to hold its shape under traffic in all conditions of weather. The methods of constructing these surfaces indicated in the accompanying typical cross sections (fig. 3) must of course be modified to suit local conditions. If intelligent care is exercised in their construction, however, they should become compact and firm under traffic, and should be easily maintained in a smooth, uniform condition by means of the road drag.

## COST OF DRAG MAINTENANCE.

Notwithstanding the fact that road drags have been widely used, there are very few reliable data available which relate to the cost of drag maintenance. Furthermore, most of the data which have been

collected are difficult to interpret, because of the fact that they do not usually furnish sufficient information concerning the character of the surface maintained or the prevailing climatic and traffic conditions to warrant any very general deductions. Sufficient is known, however, to warrant the unqualified statement that no cheaper method than dragging has ever been devised for maintaining those types of roads for which the drag is adapted.

The cost of constructing a satisfactory road drag varies from about $2, when a split-log drag is used and all materials are conveniently available, to perhaps $10 or $12, when the drag is made of first-class sawed lumber, neatly finished in every detail and painted. This item of first cost appears almost insignificant when it is con-

FIG. 6.—Topsoil road in Virginia before instituting drag maintenance.

sidered that the life of a well-constructed road drag should be at least three or four years.

The cost of operating a drag varies, of course, with the cost of labor and team hire. Accurate data kept by a representative of the Office of Public Roads in Bennington County, Vt., during 1912 and 1913, showed that under favorable conditions a road could be dragged at the rate of about 1 mile per hour. This was where the road was comparatively well shaped and only one trip in each direction was necessary. Where more trips of the drag were required, the rate was, of course, correspondingly diminished. In this county teams with drivers cost from $3.50 to $5 per working day of from 8 to 10 hours, and the cost per mile for dragging a road one time showed a corresponding variation. The number of draggings neces-

sary per year varied over a wide range and depended on the length of time that the road had been constructed and the character of material composing the surface.

The average cost per mile of dragging an earth road 8 miles long in Alexandria County, Va., during 1911 and 1912 was $1.25 for each dragging, including an average of three round trips. This road was being maintained as an experiment by the Office of Public Roads, and the above cost is based on 24 draggings during the first year.

Probably the most economical and efficient system of managing drag maintenance is to assign definite sections of road to each of several responsible interested residents who own teams and live conveniently near the road. In this way the men and teams who

FIG. 7.—Topsoil road shown in figure 6 after instituting drag maintenance.

do the dragging will be occupied in other work when not engaged in dragging the road, and need be paid only for the actual time employed. This system also creates a wholesome spirit of rivalry among those in charge of different sections of road and good results naturally follow.

## CONCLUSION.

In conclusion it seems well to summarize a few of the principal points which have already been discussed at some length.

First, the road drag is the simplest and least expensive contrivance yet devised for maintaining roads constructed of earth or earthy material. Second, the successful operation of a road drag depends to a very great extent on the skill and intelligence of the operator. Third, the time to use the drag is when the material composing the

road surface is sufficiently moist to compact readily under traffic after it has been moved by the drag and does not contain sufficient moisture for the traffic following the drag to produce mud. Fourth, dragging can not usually be so arranged as to keep teams employed all the time, and it is therefore desirable to have it done by interested

FIG. 8.—Gravel road, Arlington, Va., showing the result of experimental drag maintenance under the supervision of the Office of Public Roads.

persons who can find employment for themselves and teams when they are not engaged in dragging.

Figures 4 to 8, inclusive, show a few of the advantages which some communities are now deriving from the intelligent use of the road drag, and a study of these should prove instructive as well as interesting.

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